Space Weather Technical Forecast

Issued on Tuesday, 28 May 2024 at 00:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing likelihood of further M-class or X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with one X-class flare observed, peaking X2.8 at 27/0708UTC from over the southeastern limb, almost certainly from ex-AR3664. This is now in the process of rotating onto the southeast limb. While currently impossible to analyse, the magnetic structure above the spot can be observed rebuilding in SDO imagery after the recent flare, and further flares remain likely. There are eight numbered regions currently on the Earth-facing disc, however most are small and simple. The exception is AR3691 in the northeast. Gradual growth of the region has led to an increasing trend to its penumbral area, and the development of a broad delta configuration, albeit rather weak with limited twisting of its magnetic field. Some minimal growth has also been observed elsewhere on the disc including AR3693 and AR3695, both also in the northeast.

No Earth-directed CMEs have been observed, with all previous observed CMEs assessed as missing. The moderately fast CME from the X-class flare is directed away from Earth, due to the east limb location of the source.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at ACE at L1, briefly rose to be slightly elevated at just over 400km/s between 27/0130-0520 UTC, but then eased to be mainly background at 350-380 km/s, with below average density. Interplanetary Magnetic Field (IMF), Bt, was weak, between 3-8nT, with the north-south component, Bz, also weakly varying between +6nT and -5nT, but favouring a negative (southward) orientation. Phi angle was positive (away from the Sun) until 27/1800 UTC, then rotated to be negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 (greater than 10 MeV) remained at Background. High energy electron flux (greater than 2MeV) at GOES16 varied between Background and Moderate. Associated 24-hour fluence remained below the Active threshold. Observed fluence at 28/00000 UTC was 6.17e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected with a likelihood of further M-class flares, and a chance of isolated X-class flares. These most likely from returning spot ex-AR3664, now on the southeast limb, but also potentially from AR3691 in the northeast.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds may see a brief enhancement from any fast wind of CH40/+ on day 1 (28 May), however only a limited enhancement is likely, with solar winds perhaps reaching 400-450km/s, before easing back to background day 2 onward (29 May). This enhancement is low confidence as well, with the potential for background winds to persist. Mainly Quiet geomagnetic activity expected with Unsettled intervals, and a slight chance of Active with any fast wind onset day 1.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background throughout, with only a slight chance that any flaring from the current active sunspots will lead to observable high energy protons at Earth. High energy electron flux is also forecast to persist at

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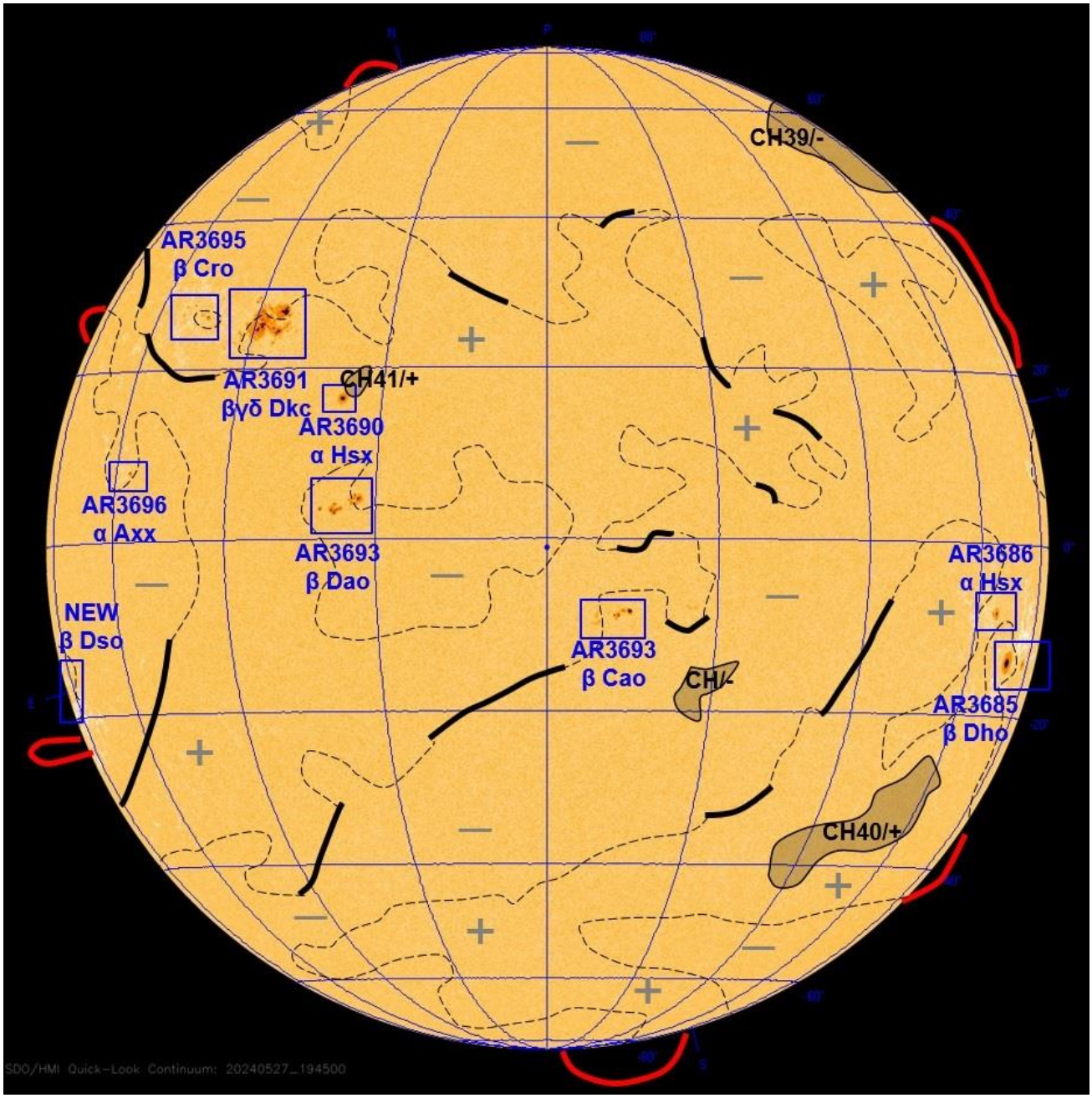
mainly background, The associated 24 hour fluence is expected to remain below Active.

Figure 1. Solar Analysis Valid 27/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

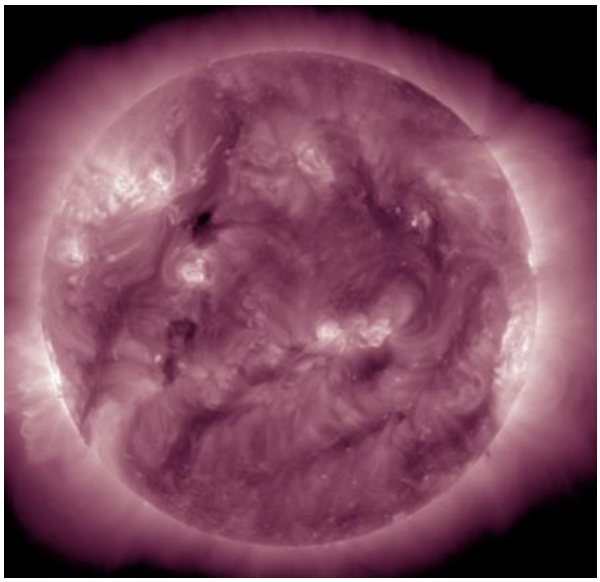
Solar winds are currently background, near 350km/s, with the only potential enhancements currently anticipated from the small far south coronal hole CH40/+ on day 1 (28 May). Solar winds may briefly increase to be slightly elevated for a time, perhaps to around 400-450km/s, before easing to background again day 2 onward. Geomagnetic activity is expected to be mainly Quiet, with only a slight chance of Unsettled intervals. Any brief coronal hole enhancement on day 1 (28 May) will bring a slight chance of G1 Minor Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil

Figure 2: SDO aia-211 showing the lack of notable coronal holes on the Earth-facing disc



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Radio Blackouts - X-Ray Flares:

Moderate to High activity likely, with the return of ex-AR3664 onto the southeast limb, along with developing AR3691 in the northeast. These bringing a likelihood of further isolated M and X-flares.

Ex-AR3664 has already produced one X-flare on 27 May, despite being just around the southeast limb, and was the source of eleven X-flares on the previous solar rotation. It remains to be seen how much of the sunspot persists from the previous rotation, as it is yet to become fully visible, and it will receive a new number once it is. However some lead penumbra is evident on the limb along with SDO imagery showing rebuilding magnetic looping above the region after the 27 May X-flare. Given the recent activity, further M or X class flares are likely.

AR3691 in the northeast disc also brings a notable flare risk, with ongoing penumbral growth through the last 48 hours and the development of a broad but weak delta spot configuration. While the magnetic structure only shows limited twisting of the fields, this region also has the potential for notable flares, including a slight chance of isolated X-flares. The other regions on the disc remain relatively small and simple, although some slight growth has been observed, most notably in AR3693, a more equatorial spot also on the northeast disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	75	75	70	70
Very Active	R3 to R5 X Class	Yes	25	25	20	20

Figure 3a: GOES-16/18 X-ray flux

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Figure 3b: SDO imagery at time of issue, of AR3691 (and AR3695) in the northeast (top) and the new region (ex AR3664) rotating on the southeast limb (bottom)

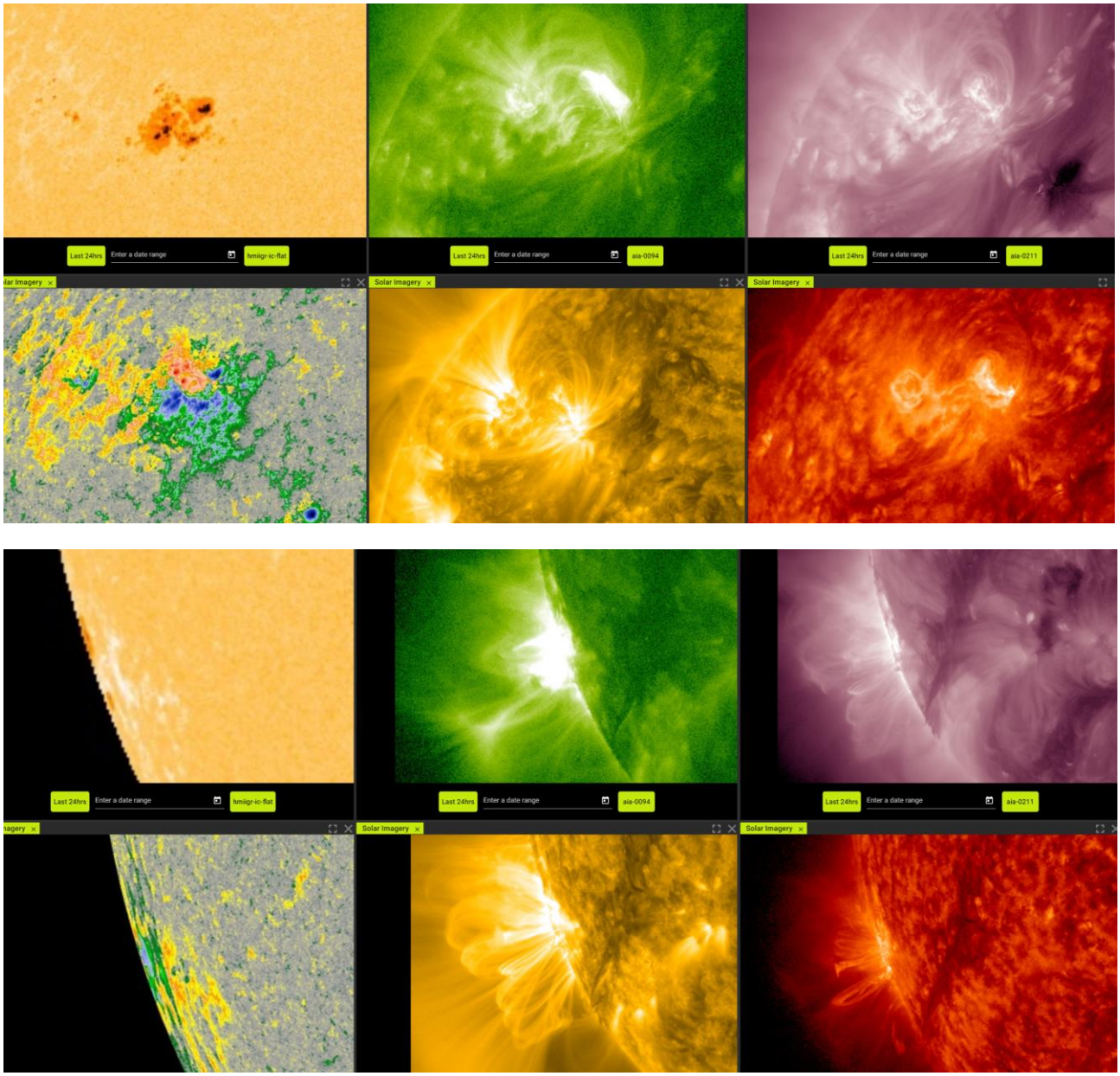
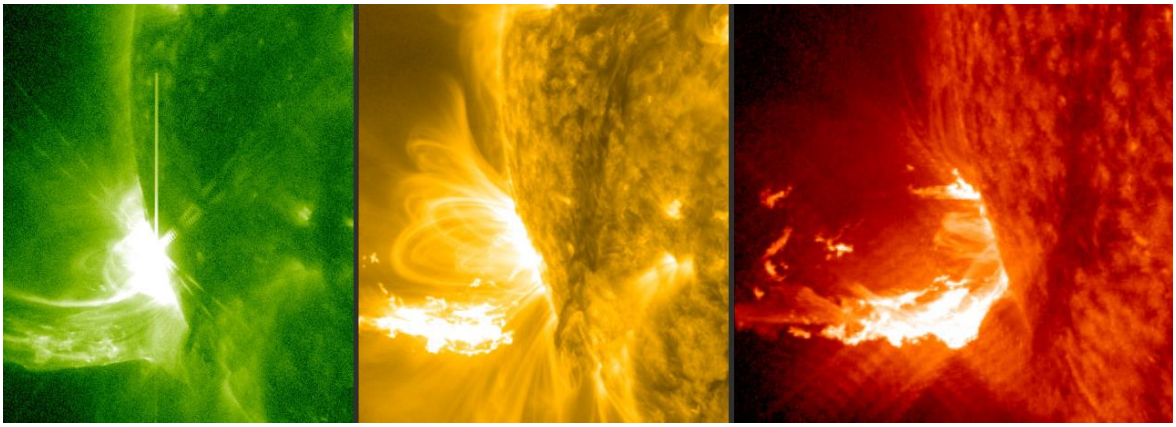


Figure 3c: SDO imagery of X2.8 flare from over the SE limb



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Solar Radiation Storms - (High Energy Protons):

GOES-18 proton flux is currently expected to persist at background, with only a slight chance of rising towards the S1 threshold given any further notable flares. These are most likely from either ex-AR3664, over the southeastern limb or AR3691 in the northeast disc, however eastern disc flare locations are much less likely result in an increase to the observed proton flux at Earth, as protons have a tendency to follow the Parker Spiral, away from Earth. However sufficiently energetic events still have the potential to be observed.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

GOES-16 electron flux is currently mainly background with only brief diurnal increases to Moderate possible. There is a slight chance of a weak connection to CH40/+ day 1-2 (27-28 May), perhaps further suppressing the electron population at GEO on onset, with little enhancement forecast to follow.

The associated 24 hour electron fluence is expected to remain below the Active level, as supported by MOSWOC REFM, which is currently providing good guidance for the expected trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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